1. Summary

Presently, in North Carolina the bag-house materials used in hot-mix-asphalt (HMA) are purged intermittently into the AC mixtures rather than being stored in a silo and added to the mixture as mineral filler in a uniform, controlled manner. Previous studies have shown that the volumetric properties of asphalt mixtures are greatly influenced by the source and gradation of the baghouse fines. Due to this reason, several states require contractors to waste baghouse fines. However, there is some environmental concern in wasting the fines.

Recent NCDOT research suggest that baghouse fines with gradation similar to the natural and manufactured fines passing #200 sieve, seems to have beneficial effect on stiffness and rutting characteristics of the asphalt mix. However, these studies conclude that mixes containing baghouse fines were highly moisture susceptible, and recommended that baghouse fines be metered into the mix to create a uniform percentage throughout the mix.

This research proposes to conduct a laboratory study of moisture sensitivity of asphalt mixes containing controlled percentages of Boone and Enka baghouse fines in the amount of 0, and 4-percent. In this study, lime will be used as an anti-strip agent to determine its effectiveness in mitigating moisture damage. The results of this study will complete, and support the outcome of the previous NCDOT studies that investigated mitigation of moisture susceptibility of mixes containing baghouse fines with organic anti-strip additives. The recommendations based on results of this study should enable NCDOT to formulate specifications with regards to the use of baghouse fines in NCDOT mixes. Three possible outcomes that may be pursued are: 1) waste baghouse fines all together; 2) require use of baghouse fines in uniform controlled manner; 3) require use of lime as anti-strip additive in lieu of the use of organic anti-strip additives.

2. Background

Presently, in North Carolina the bag-house materials used in hot-mix-asphalt (HMA) are purged intermittently into the AC mixtures rather than being stored in a silo and added to the mixture as mineral filler in a uniform, controlled manner. A survey of departments of transportation (DOTs) conducted by Hanson and Cooley (1997) indicates that 18 states consider baghouse fines to be detrimental to the life of (HMA). Five states – Arizona, Montana, Nevada, North Dakota, and Wyoming – require the contractor to waste the baghouse fines. This is because depending on the source and gradation, the percentage of baghouse fines greatly influences the volumetric properties of HMA and therefore laboratory mix design must include the use of these fines when developing the job mix formula.

Recently completed NCDOT research studies [1, 2, and 3] indicated that several performance properties of HMA increased with the use of baghouse materials. However, even though the TSR moisture sensitivity test (AASHTO T238) indicated that mixes containing baghouse fines with organic anti-strip additive were acceptable based on the NCDOT criterion, the collective conclusion from these studies was that these mixes were highly moisture sensitive. To complicate the matter, there have been instances in North Carolina where pavements have been constructed with contractor not using the anti-strip additive. Further more, it may be possible that the organic anti-strip additive is not uniformly distributed in asphalt binder; and prolonged heating and storage of the asphalt binder prior to its use may actually result in some loss and effectiveness of the organic anti-strip additive. In this case, mixes containing excess purged baghouse fines will be extremely susceptible to moisture damage and therefore, premature pavement failure.

Currently, NCDOT has two alternatives dealing with purging baghouse fines in mixes – 1) waste all baghouse fines, and 2) uniformly meter baghouse fines into mixes. The first alternative may not be viable as it will not only be expensive to rid the fines but will certainly have environmental repercussions. The second alternative can be implemented at significant cost to mix producers, keeping in mind that it will still require vigilant control over the use of organic anti-strip. Any slip in control can result in significant cost to NCDOT.

Some states, for example – South Carolina, Georgia, Mississippi, Texas, and Utah, exclusively require use of lime as an anti-strip additive. Many states allow contractors to choose between lime and organic liquid anti-strip additive. Lime as an anti-strip additive is not currently used in North Carolina. Therefore, the question that remains to be answered with regards to the use of baghouse fines is – can lime be an effective anti-strip additive for North Carolina mixes containing excess (purged) baghouse fines? It is critical to answer this question before NCDOT can take any action towards formulating any specifications with regards to use of baghouse fines.

3. Research Objectives and Scope of the Study

The objective of this research will be to evaluate the use of lime as anti-strip additive for mitigating the moisture susceptibility of asphalt mixes containing baghouse fines. Two baghouse fines – Boone and Enka that has been used in prior NCDOT studies [2, 3] will be evaluated. This will allow direct comparison of the same mixes containing organic liquid anti-strip with those containing lime as anti-strip.

One percent lime is generally used in mixes. However, there are two methods of incorporating it in the mix. One is the dry method in which lime is added directly to aggregates during mixing. The other is the wet method where aggregates are soaked in lime slurry and then dried. These lime coated aggregates are then used for preparing mixes. In this study, dry method of incorporating lime will be evaluated. In particular, the principal work tasks are:

a) Provide summary of literature review to determine the current state of practice regarding use of lime to mitigate moisture susceptibility of asphalt mixes when baghouse fines are used in the mix.

b) Design asphalt mixes using Superpave mix design methodology with mixes containing two types of baghouse fines, Boone and Enka, used in previous NCDOT study. The baghouse fines used will be in the amount of 0, and 4-percent by the weight of total aggregate. It should be noted that JMF requires 1.5% baghouse fines in the mix. Therefore, the actual baghouse fines content in the mix will be 1.5, and 5.5-percent,

with additional 1.0 percent lime. The control mix in this case will contain the maximum 6.5 percent baghouse fines.

c) Determine the moisture susceptibility of the designed mixes using the TSR test.

d) Evaluate the performance of the mixes in terms of shear stiffness, rutting, and fatigue resistance.

4. Research Methodology

This research study will be conducted in five specific tasks corresponding to the objectives stated in section 3. The work plan for each task is briefly discussed in the following sections. Figure 1 shows the summary of research approach to be used for the various tasks.

4.1 Task 1 – Literature review

In this task, a comprehensive literature survey will be conducted and the results summarized for the state of the practice with regards to the use of baghouse fines in asphalt concrete. It should be noted that this study proposes to use lime in dry process. However, based on the literature review and in consultation with NCDOT, it may be necessary to use lime in wet process as opposed to the dry process.

4.2 Task 2 – Superpave mix design for surface mix

Materials that will be used in this study will be the same as those used in recently completed NCDOT study "*Effect of Percentage Baghouse Fines on the Amount and Type of Anti-Stripping Agent Required to Control Moisture Sensitivity*" [3]. These materials consisted of baghouse fines from Boone and Enka plants. The only difference in this study as compared to the previous study will be that the maximum percentage of baghouse fines used will be 5.5 percent (as opposed to 6.5 percent). Lime will substitute the 1 percent difference. A lot of experience was obtained during the last study with Superpave mix design for NCDOT surface mix. Therefore same aggregate materials and gradations will be used in this study, and the volumetric properties

of the mixes will be verified. It should be noted that this task will evaluate 6 mixes – 3 with Boone and 3 with Enka baghouse fines. The amount of filler material (passing #200sieve) will be kept constant at 6.5 percent. The control mix will have the maximum amount of baghouse fines with no lime, whereas, the other two mixes will contain 1.5 and 5.5 percent baghouse fines with 1 percent lime.

4.3 Task 3 – Moisture susceptibility

Based on the optimum asphalt content selected (Task 4.2) for each of the six mixes, eight TSR specimens will be prepared using gyratory compactor according to NCDOT specifications to study the moisture susceptibility of these mixes. This task will show whether the amount of lime incorporated will be sufficient to mitigate moisture sensitivity.

4.4 Task 4 – Mix performance

In this task, specimens will be prepared using gyratory compactor for the performance testing. Unconditioned and moisture conditioned specimens will be subjected to shear frequency sweep test and the repeated shear test at constant height. Based on the results of the test, the rutting and fatigue performance of these mixes will be evaluated. Specimens will also be subjected to APA test at NCDOT Materials and Test Unit. Specimens for the APA test will be fabricated at NCSU and will be provided to NCDOT.

4.5 Task 5 – Quarterly and final reports

As per the NCDOT requirement, quarterly reports will be submitted every quarter and a final report at the end of the project. The final report will include the results of the present study as well as comparison with the results obtained in the previous study using organic anti-stripping agent.

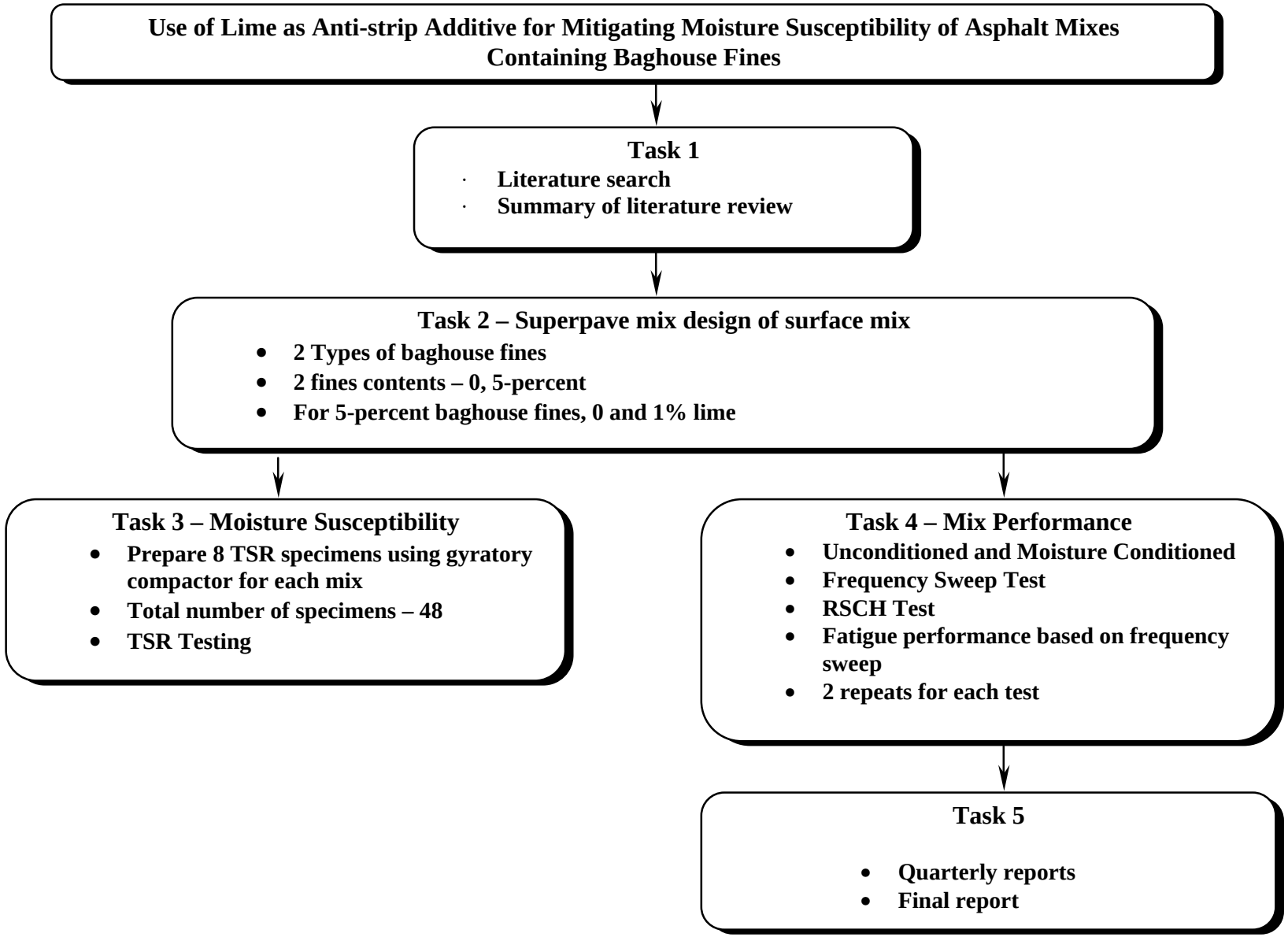

Figure 1 -- Summary of research approach and methodology

5. Significance of Proposed Work

The anticipated results of this research study will be a clear understanding of the significance of the use of baghouse fines in asphalt mixes used in the state of North Carolina, vis-à-vis comparison between mixes containing lime and organic anti-stripping agent.

6. Recommendation for Implementation and Technology Transfer

Results of this study will enable NCDOT to make proper judgment regarding the use of baghouse fines in NCDOT mixes. It will provide one more alternative in addition to either waste the fines or require producers to uniformly incorporate baghouse fines in mixes as opposed to purging them. If the producers are required to uniformly incorporate baghouse fines, use of either organic anti-strip or lime will still need to be used. However, use of lime as anti-strip additive may allow producers to purge the baghouses.

7. Resources to be Supplied by NCDOT

Resources that will be required from NCDOT will be the materials, conducting the TSR tests, and moisture conditioning of the specimens, and APA testing. All specimens will be fabricated at NCSU and supplied to NCDOT.

8. Equipment and Facilities

The Department of Civil Engineering at the North Carolina State University has extensive array of equipment necessary to successfully complete this study. The major equipment items necessary for this project include 1) the Superpave™ test equipment (SGC) including the sieving machine and equipment for various types of specific gravity; and 2) SHRP shear test equipment for asphalt concrete material characterization.

9. Proposed Work Schedule

This project is proposed to be of 12 months duration starting July 1, 2004 to June 30, 2005.

10. List of Current Research Project Commitments

The proposer of this research study has the following current research project commitments:

Title: Quantifying Anti-strip Additive in Asphalt (Binder & Mixes)
Project Duration: July 1, 2003 to December 31, 2004
Project Sponsor: NCDOT

11. Cited Publications by Proposing Researchers

a) Tayebali, A. A., G. S. Natu, and M. Kulkarni, "Comparison of Material Properties and Life of Pavement Sections Containing Mixes with and without Non-Strip Additives," Technical Assistance to NCDOT Report No. 98-03, Center for Transportation Engineering Studies, Department of Civil Engineering, North Carolina State University, June 1998.

b) Tayebali, A. A., M. Kulkarni, and H. F. Waller, "Delamination and Shoving of Asphalt Concrete Layers Containing Bag-House Fines," NCDOT Report No. HWY 99-03, Department of Civil Engineering, North Carolina State University, May 2000.

c) Tayebali, A. A., W. K. Fischer, Y. X. Huang, and M. B. Kulkarni, "Effect of Percentage baghouse Fines on the Amount and Type of Anti-Stripping Agent Required to Control Moisture Sensitivity," NCDOT Report No. HWY 2003-04, Department of Civil Engineering, North Carolina State University, June 2003.

12. Cited Publications by Others

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Puzinauskas, V., "Filler in Asphalt Mixtures," *The Asphalt Institute Technical Report RR-69-2,* (April -1983), pp. 493-528.